CHAPTER 13:
EXPERIMENTS & OBSERVATIONAL STUDIES

Example:

You work for botanical company and with your team you have developed a new type of potting soil specifically designed to improve the growth and development of roses. An experiment needs to be designed to show that your soil works well compared to regular soil and the leading competitor.

How can you design a good, random, experiment?

Some vocab...

Experiments:

* Impose a treatment

* manipulates factor levels to create treatments

* randomly assigns subjects to these treatment levels

* compares the responses of the subject groups across treatment levels

Experimental Units-

* Individuals on which the experiment is done

Ex: cars, roses, etc.

Subjects-

* Human experimental units

e.u.'s

Factor-

* explanatory variable
* levels controlled by the experimenter.
* Experimenters try to discover how different factor levels affect the responses of the experimental units.

Example: measuring the affect of 2 fertilizers and 3 water amounts on plant growth. ***Factors = Fertilizer and Water***

Level-

* The specific values a factor can take

Treatments-

* a combination of levels of each factor
* the SPECIFIC thing being done to each group of experimental uni

Example: measuring the affect of 2 fertilizers and 3 water amounts on plant growth.

Factors = Fertilizer and Water
Levels = Fertilizer: A and B Water: 100mL, 200mL, 300n
Treatments = A & 100mL A & 200mL A & 300mL
B & 100mL B & 200mL B & 300mL

Response Variable-

* What is measured and used for comparison
* Can be more than one thing

Example: plants and fertilizer and water again

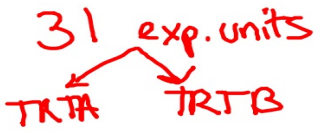
Response variables = height of plant in inches
width of plant in centimeters
number of buds on plant
number of leaves on plant
color of plant

When designing experiments...

PRINCIPALS OF EXPERIMENTAL DESIGN

1) CONTROL:

* As many aspects of the experiment as possible
* Lurking variables



2) RANDOMIZATION:

* Of exp. units into treatment groups

- Assign each exp. unit in sample a number

- Use Table of Random Digits to assign exp. units as evenly as possible to treatments

3) REPLICATION:

* on many different exp. units
* on many different samples from same population
* helps show validity of results if you replicate and see same results

Some more vocab...

Control Group –

* experimental unit that is assigned the baseline treatment: either no treatment, the default (old) treatment, or placebo

Placebo –

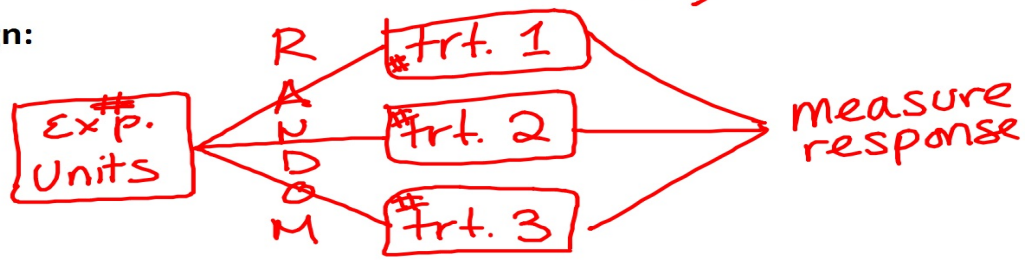
* a treatment known to have no effect, a dummy treatment.

* as similar to real one as possible

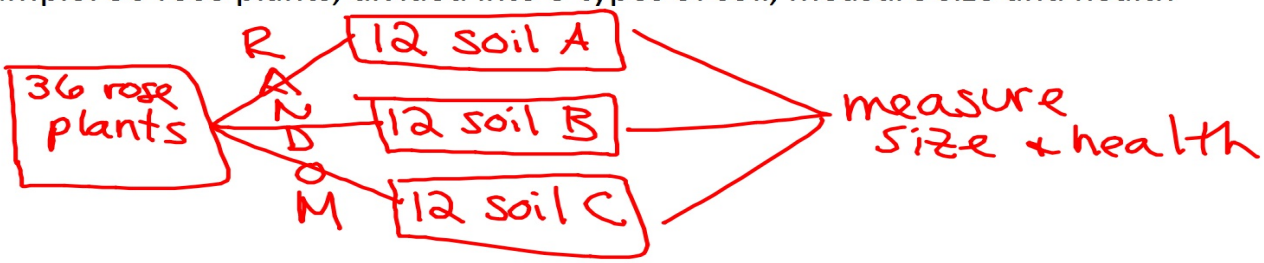
Placebo Effect –

(1) Completely Randomized Design (CRD)

Design:



Example: 36 rose plants, divided into 3 types of soil, measure size and health



Other:

- ***Single blind:***
  - When the exp. units do not know which one of them is getting which treatment

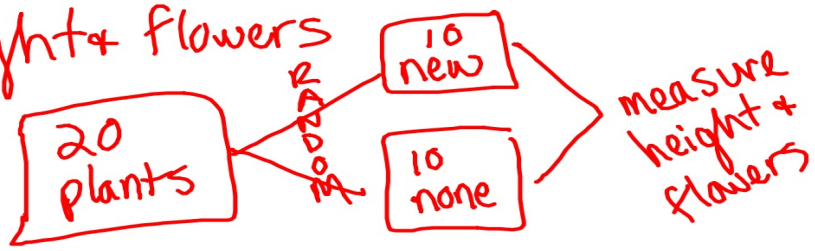
- ***Double blind:***
  - When both the experimental units and the administrators/judges don't know who is getting which treatment

Example 1: I want to test out a new plant food. So I take 20 plants, and give half the new plant food and half no food at all. All of the plants get the same amount of water and sunlight each day. After 30 days, I measure the height that the plant has grown, and also how many flowers it has on it.

Individuals:
Factor(s): Food
Level(s): new & none
Treatment(s): new & none

Response Variable: height & flowers

Design the experiment:



Example 2:
High cholesterol level in people can be reduced by exercise or by drug treatment. A pharmaceutical company developed a new cholesterol-reducing drug. Researchers would like to compare the effects of the new drug with the currently used and accepted drug. 100 Volunteers who have a history of high cholesterol and who are currently not on any medication will be recruited to participate.

What are the treatments? What are the subjects/individuals?

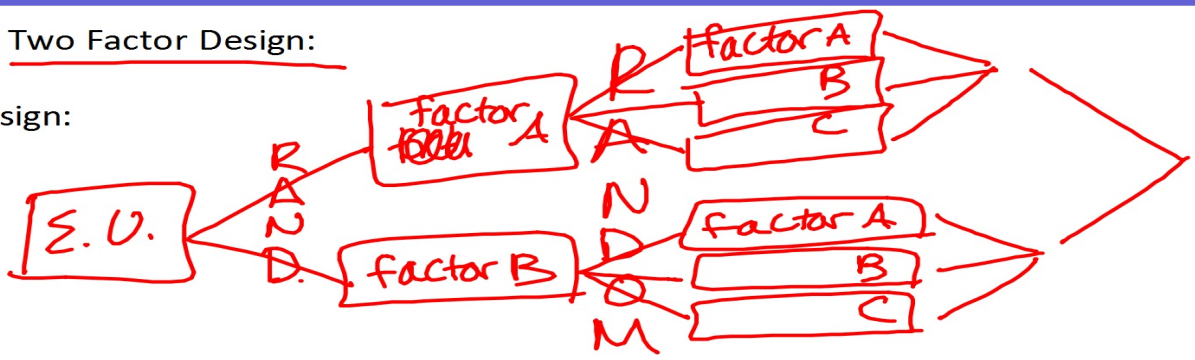
What is the response variable?

Would a placebo group be appropriate/necessary? Why or why not?

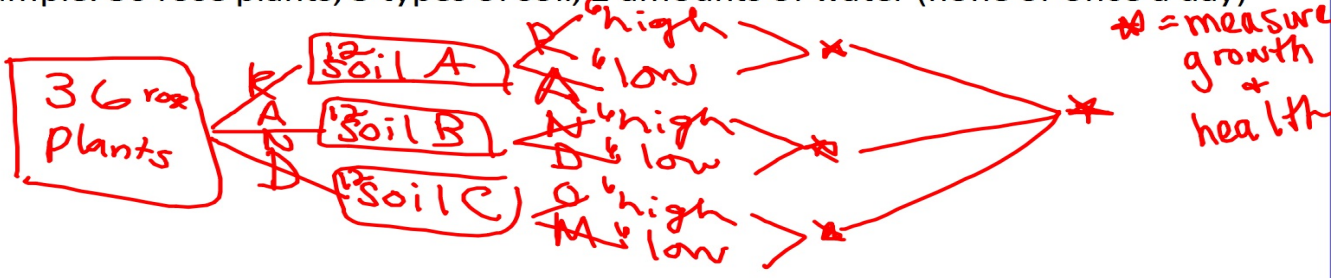
Design the experiment below:

(2) Two Factor Design:

Design:



Example: 36 rose plants, 3 types of soil, 2 amounts of water (none or once a day)



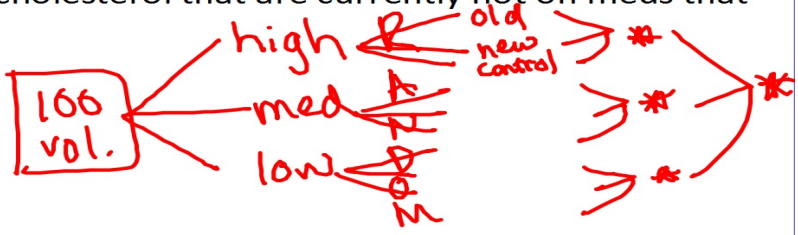
(3) Block Design (Blocking)

BLOCK = group of similar exp. units that would have an affect on the results.
Examples: gender, age, breeds, etc.

lurking variables

Design: Example: Block the roses based on type of rose (alba rose and rock rose)

Example 3:
Let's go back to the experiment on people with high cholesterol. We wanted to test the effect of new and old drug. We also thought a control group would be useful. There are 100 volunteers with high cholesterol that are currently not on meds that are available.



Individuals:
Treatment(s):
Response Variable:

What are some lurking variables in this experiment?
exercise, diet, fam. hist. etc.

Using this variable, create a block design experiment

Example 4: Men and women respond differently to advertising. An experiment to compare the effectiveness of 3 TV commercials for the same product will want to look separately at the reactions of the different genders, and assess their overall responses to the ads. There are 70 people available for the experiment.

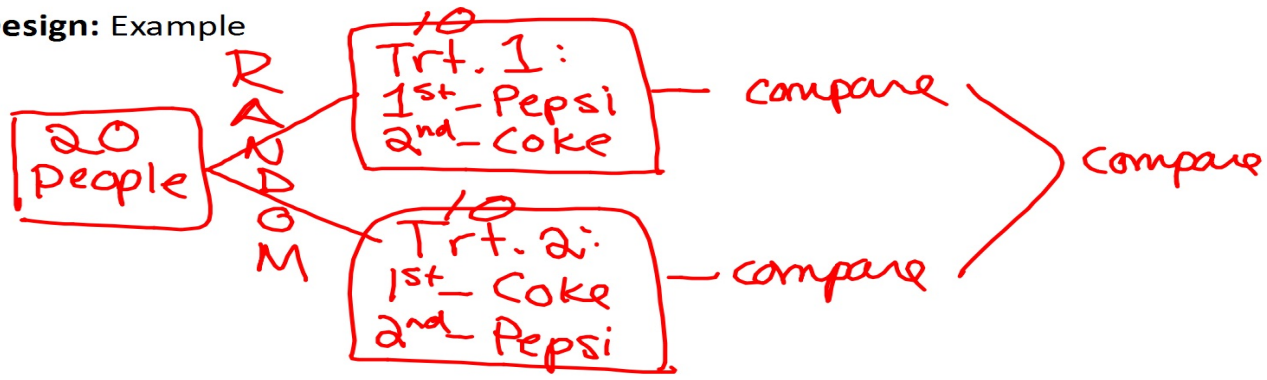
What are some lurking variables in this experiment?

Using this variable, create a block design experiment

(4) Matched Pairs Design

- Usually only 2 treatments
- Each experimental unit gets both treatments
- Randomization comes by which treatment comes 1st or 2nd (or L and R)
- ✳ Can also be where two subjects with equal characteristics are given different treatments and then compared

Design: Example



Example 5:
We want to test the effectiveness of two types of tires (call them A and B) on cars. We gather 50 different cars for our experiment. We will be measuring the amount of wear on the two types of tires. The cars will be driven normally for 3 months. How could we BEST design this experiment?

(A) What are the individuals? What is the response variable?

(B) What are the treatments?

(C) Design the experiment (matched pairs):

(D) Can this experiment be single or double blind?

Example 6:
Go back to the car tires experiment. Suppose the cars were all different (SUVs, sports cars, sedans, trucks, etc.). How would you reduce this lurking variable of car size/type?

** you can block in any experiment, if you feel it is necessary**

The best experiments are usually:

- Randomized
- Double-blind
- Comparative
- Placebo-controlled

Confounding –

* when levels of one factor are associated with the levels of another factor so their effects cannot be separated

Ex: diet & exercise on weight

Lurking Variable –

* variable that has an important effect on the relationship among variables but is not included in the study/expt.

Ex: wine vs. heart disease

Statistically Significant –

* seeing an observed effect (or difference)so often, that it is most likely not due to chance, and is the true response in the study/expt.

Example: #41 in book:

A study published in *New England Journal of Medicine* suggests that it's dangerous to enter a hospital on the weekend. During a 10-year period, researchers tracked over 4 million emergency admissions to hospitals in Ontario, Canada. Their findings revealed that patients admitted on weekends had a much higher risk of death than those who went on weekdays.

(a) The researchers said the difference was statistically significant. What does this mean in context?

(b) What kind of study was this?

(c) If it is Saturday, and you are feeling really sick, should you wait til Monday to see medical help?

(d) Suggest some possible confounding or lurking variables.

Observational Studies:

* researchers do not impose a treatment on the exp. units. Simply observe

Retrospective Study:

* Select exp. units and then ask about previous behaviors & conditions

Prospective Study:

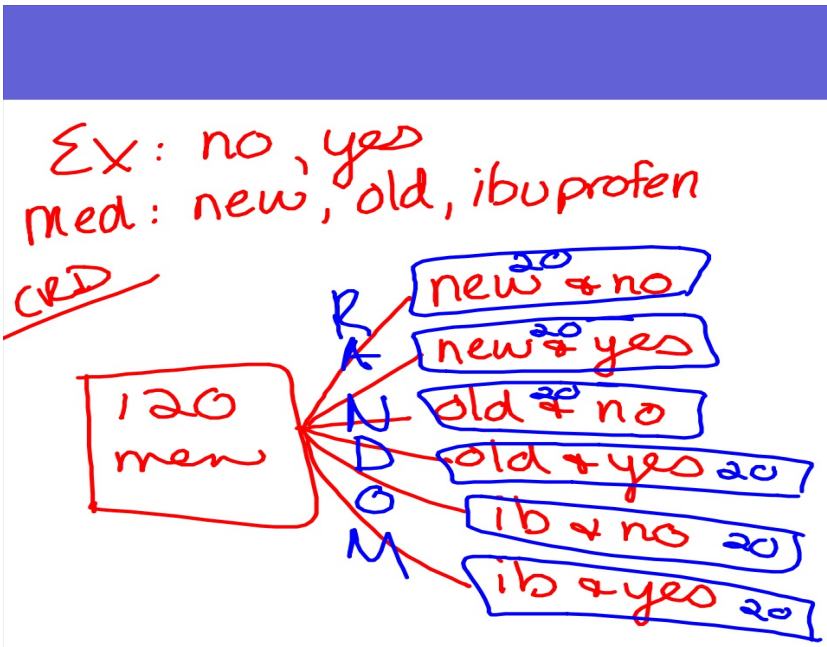
* Identify exp. units in advance and then collect data as events unfold (follow them)

- Complete the packet of AP problems

- Check your answers with the answer key on the front desk

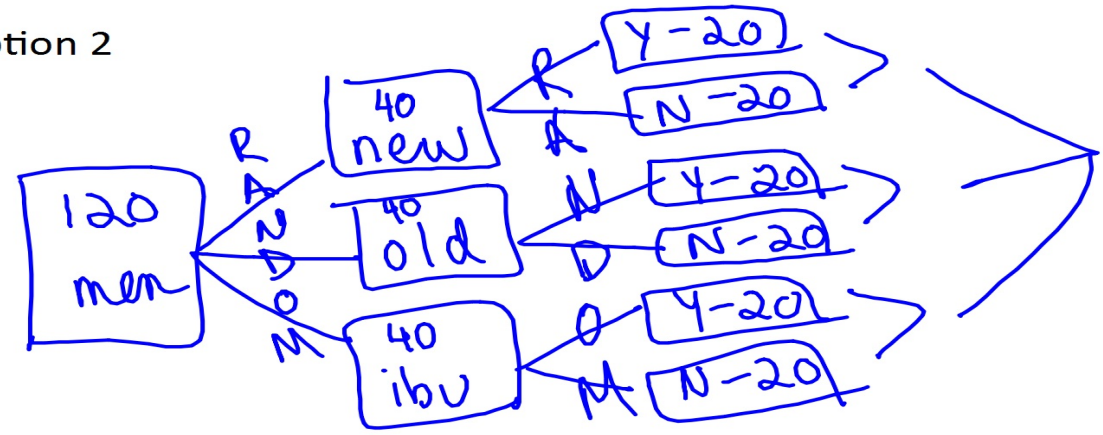
- complete the experimental design review problems worksheet, #1-5

- check answers with answer key on front desk


Ex: no, yes
med: new, old, ibuprofen
CRD
120
men
RANDOM
new 20 & no
new 20 & yes
old 20 & no
old & yes 20
ib & no 20
ib & yes 20

#1: option 1

#1: option 2


120
men
RANDOM
40
new
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old
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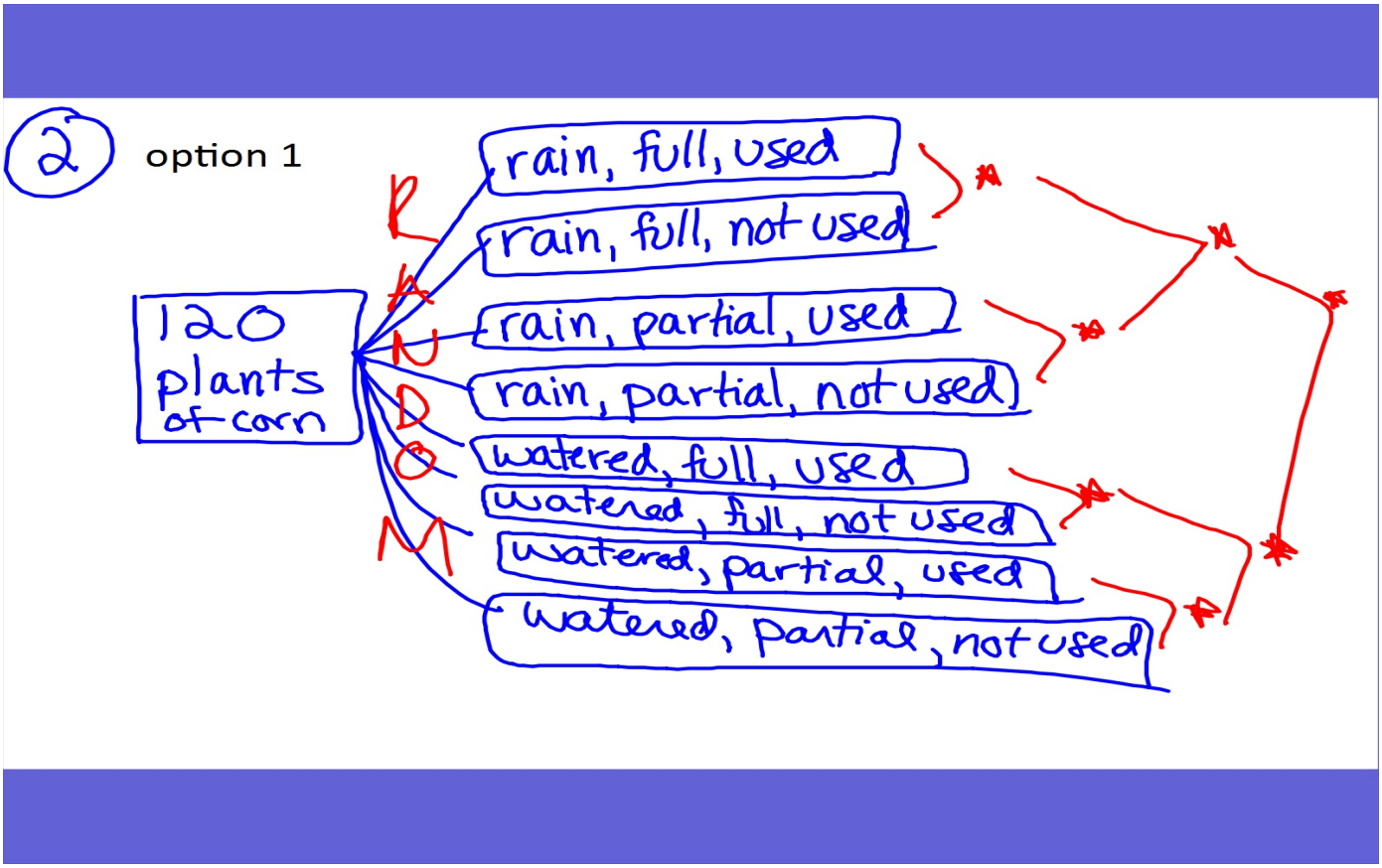
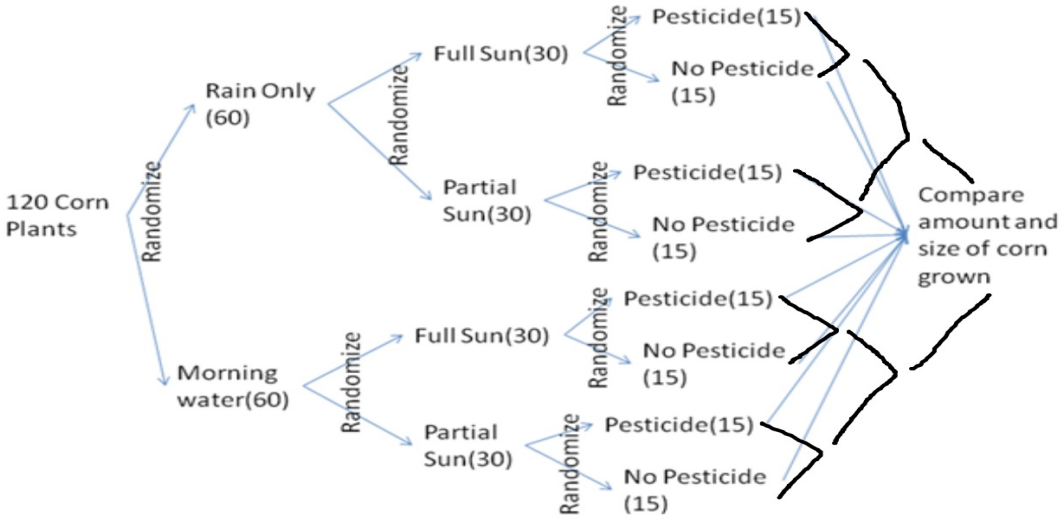

2
option 1
120 plants of corn
rain, full, used
rain, full, not used
rain, partial, used
rain, partial, not used
watered, full, used
watered, full, not used
watered, partial, used
watered, partial, not used

#2: option 2


120 Corn Plants
Randomize
Rain Only (60)
Morning water(60)
Randomize
Full Sun(30)
Partial Sun(30)
Randomize
Full Sun(30)
Partial Sun(30)
Randomize
Pesticide(15)
No Pesticide (15)
Pesticide(15)
No Pesticide (15)
Pesticide(15)
No Pesticide (15)
Pesticide(15)
No Pesticide (15)
Compare amount and size of corn grown